

CLAIMS

We claim:

1. A magnetic write head, comprising:

5 an optical element for providing a thermal gradient in a magnetic recording media, said optical element having an emitting surface; and

10 a magnetic element for providing a magnetic field gradient in the magnetic recording media, said magnetic element located on said emitting surface.

2. The magnetic write head recited in claim 1, wherein said optical element is a very small aperture laser (VSAL).

15 3. The magnetic write head recited in claim 2, wherein said optical element includes a reflective film structure over the emitting surface, said reflective film structure having a small aperture for emission of laser light.

20 4. The magnetic write head recited in claim 1, wherein said magnetic element comprises an electrically conductive layer providing a path for electrical current flow.

25 5. The magnetic write head recited in claim 1, wherein said magnetic element comprises a ferromagnetic layer providing a

magnetic pole, said ferromagnetic layer inductively coupled to a electrically conductive coil for inducing magnetic flux in said ferromagnetic layer.

5 6. A magnetic write head, comprising:

 a very small aperture laser (VSAL) having an emitting surface;

 a multilayer thin film structure over the emitting surface, said multilayer thin film structure having a very small
10 aperture for emission of laser light from the VSAL, said multilayer thin film structure comprising:

 a reflective conductive layer; and

 an insulating layer disposed between the reflective conductive layer and the emitting
15 surface.

 7. A magnetic read/write head, comprising:

 a magnetic write head, including:

 an optical element for providing a thermal gradient in
20 a magnetic recording media, said optical element having an emitting surface and a side surface; and
 a magnetic element for providing a magnetic field gradient in the magnetic recording media, said magnetic element located on said emitting surface;
25 and

a magnetic read head adjacent to said side surface, said read head including a magnetoresistive sensor.

8. The magnetic read/write head recited in claim 7, wherein
5 said magnetoresistive sensor is a giant magnetoresistive (GMR) sensor or a magnetic tunnel junction (MTJ) sensor.

9. A magnetic read/write head, comprising:
a write head, including:

10 a very small aperture laser (VSAL) having an emitting surface and a side surface;

a multilayer thin film structure over the emitting
surface, said multilayer thin film structure having a
very small aperture for emission of laser light from
15 the VSAL, said multilayer thin film structure
comprising:

a reflective conductive layer; and
an insulating layer disposed between the
reflective conductive layer and the emitting
20 surface;

a read head, including:

first and second magnetic shield layers;
first and second nonmagnetic gap layers disposed
between said first and second magnetic shield layers;

a magnetoresistive sensor disposed between said first
and second nonmagnetic gap layers; and
an interface layer disposed between the read head and the
side surface of the VSAL.

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10. A disk drive system, comprising:

a magnetic recording disk;

a magnetic read/write head for magnetically recording data
on the magnetic recording disk, said magnetic read/write head

10 comprising:

a magnetic write head, including:

an optical element for providing a thermal
gradient in a magnetic recording media, said
optical element having an emitting surface and a
side surface; and

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a magnetic element for providing a magnetic field
gradient in the magnetic recording media, said
magnetic element located on said emitting
surface;

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a magnetic read head adjacent to said side surface,
said read head including a magnetoresistive sensor;

an actuator for moving said read/write head across the
magnetic disk so that the read/write head may access different
regions of the magnetic recording disk; and

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a recording channel coupled electrically to the write head
for magnetically recording data on the magnetic recording disk
and to the magnetoresistive sensor of the read head for detecting
changes in the resistance of the magnetoresistive sensor in
5 response to magnetic fields from the magnetically recorded data.

11. The disk drive system recited in claim 10, wherein said
optical element is a very small aperture laser (VSAL).

10 12. The disk drive system recited in claim 10, wherein said
optical element includes a reflective film structure over the
emitting surface, said reflective film structure having a small
aperture for emission of laser light.

15 13. The disk drive system recited in claim 10, wherein said
magnetoresistive sensor is a giant magnetoresistive (GMR) sensor
or a magnetic tunnel junction (MTJ) sensor.

14. A method of writing data on a magnetic recording media
20 comprising the steps of:

- a) providing a write head including a magnetic element for
providing a magnetic write field gradient and a thermal element
for providing a thermal gradient in the magnetic recording media;
- b) providing a thermal spring magnetic recording media
25 having first and second Curie temperatures;

c) heating a region of the magnetic recording media moving with respect to the write head to a temperature between said first and second Curie temperatures by using light emitted from said thermal element; and

5 d) applying a write current to the magnetic element to induce a magnetic write field at the region of the magnetic recording media heated by the thermal element and having a thermal gradient as it cools below said first Curie temperature.

10 15. The method of writing data recited in claim 14 wherein said magnetic write field provides a magnetic write field gradient coincident with and overlapping the thermal gradient in the magnetic recording media as it cools below said first Curie temperature.

15 16. The method of writing data recited in claim 14 wherein said thermal gradient is present at a trailing end of the region of magnetic recording media heated by the thermal element as it moves relative to the write head.

20 17. The method of writing data recited in claim 14 wherein said thermal element comprises a very small aperture laser (VSAL).

18. The method of writing data recited in claim 14 wherein the magnetic element comprises a conductive layer for conducting a write current in a direction perpendicular to the motion of the magnetic recording media relative to the write head.

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19. The method of writing data recited in claim 14 wherein the magnetic element comprises a ferromagnetic pole structure for providing a magnetic write field induced by a write current flowing in a conducting coil.

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20. The method of writing data recited in claim 14 including the further step of:

e) adjusting the intensity of the light emitted from the thermal element to provide coincidence of the thermal gradient
15 with the magnetic write field gradient in the cooling magnetic recording media.